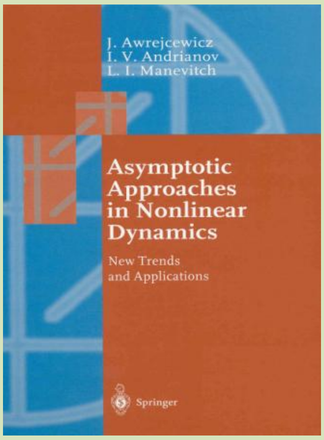
MONOGRAPHS

Professor
Jan AWREJCEWICZ

Asymptotic Approach in Nonlinear Dynamics: New Trends and Applications

(with I.V. Adrianov and L.I. Manevitch)
Springer-Verlag, Berlin 1998
monograph, 310 pages, ISBN-10: 3540638946

SUMMARY



[Preface & Contents]

[Book Review]

This book deals with asymptotic methods in nonlinear dynamics. For the first time a detailed and systematic treatment of new asymptotic methods in combination with the Padé approximant method is presented. Most of the basic results included in this manuscript have not been treated but just mentioned in the literature. Providing a state-of-the-art review of asymptotic applications, this book will prove useful as an introduction to the field for novices as well a reference for specialists. An introduction depicting the principal ideas of asymptotic approaches through simple, "transparent" examples is given. The first part is devoted to lumped systems.
First, an introduction to classical perturbation techniques is presented. A general approach to the analysis of unstationary nonlinear systems is given. Particular attention is paid to consideration of combined parametric and self-excited oscillations in a three-degree-of-freedom mechanical system. The so-called modified Poincaré approach is presented and illustrated on the basis of a one-degree-of-freedom system, and then this approach is extended to the analysis of general nonlinear systems. Then, the Hopf bifurcation is discussed from the viewpoint of the asymptotic approach. Finally, a method of controlling and improving the stability of periodic orbits of vibro-impact systems is proposed. Nonlinear normal vibrations are a generalization of normal (principal) vibrations of linear systems. In the normal mode all position coordinates can be defined from any one of them. Using normal modes of nonlinear systems gives very interesting results, and in Sect. 2.10 we write about some aspects of the asymptotic construction of an object. Progress in the applications of AM in the theory of oscillations as well as in applied mathematics on the whole is closely linked with the introduction of new smalI parameters and, respectively, new asymptotic procedures. This is the field of Sect. 2.11. In Sect. 2.12 we deal with one- and two-point Padé approximants (PA). Usually PAs are used for the extension of the area of applicability of perturbation series.
The second part specifies the most important and useful forms and techniques of asymptotic thinking for the theory of oscillations for continuall systems. Relations between the dynamics of discrete and continual systems are based on the procedures of discretization and continualization. The procedure of discretization is described well in many books, so we have paid some attention only to the continualization (the passage from discrete to continuous systems) in Sect. 3.1. Section 3.2 is devoted to the homogenization approach. Usually the averaging approach is used with respect to time variables, but in Sect. 3.3 we show new perspectives for averaging with respect to spatial variables. The idea of Bolotin's asymptotic method was generelized for the nonlinear case in Sect. 3.4. Regular and singular asymptotic in a wide rainteresting aspect of the application of these traditional approaches are notified. A new AM for

solving mixed boundary value problems is considered in Sect. 3.6. The PAs are used to remove this divergence. The TPPA in application to nonlinear dynamic problems for a continuous system -a plate on a nonlinear foundation -is displayed in Sect. 3.7. The discovery of the soliton in 1965 by Kruscal and Zabusky has brought revolutionary changes in nonlinear science, and we describe some uses of the soliton technique in Sect. 3.8. In Sect. 3.9 a nonlinear analysis of spatial structures is described on the basis of the so-called modified envelope equation.

The third part of the book includes an investigation of discrete-continuous systems. In Sect. 4.1, periodic oscillations of discrete-continuous systems with a time delay are analysed. In Sect. 4.2 a simple perturbation technique is described as it is used in the analysis of discrete-continuous systems with a time delay and with homogeneous boundary conditions. In Sect. 4.3 the nonlinear behaviour of an electromechanical system is investigated.